



CENTRAL RICE RESEARCH INSTITUTE, CUTTACK

**ANNUAL REPORT
FOR 1952-53**

PRINTED IN INDIA BY THE MANAGER
GOVT. OF INDIA PRESS, NASIK ROAD, 1954

With compliments of the
Director,
Central Rice Research Institute,
Cuttack, India.

CUTTACK

Annual Report for 1952-53

SEASON AND CROP CONDITIONS.

The 1952-53 season was not favourable for the rice crop. Sixty inches of rainfall was received, which though about normal was erratic in distribution. The monsoon commenced by the middle of June, but there was a break in the rains during July due to which transplanting operations were delayed. In September-October, when the medium duration crop was in flowering stage, there was excessive rainfall which resulted in poor setting and the yields were adversely affected. Also during October there was a severe attack of rice bug (*Leptocoris varicornis*) and the crop was dusted with BHC. Winter rainfall was also deficient and the yields of second crop legumes were poor.

AGRONOMY

A—VARIETAL TRIALS.

Five trials with 109 strains, brought forward from the previous trials and observation plots, were conducted during the main crop season. In the second crop season, a trial with 49 varieties was conducted and suitability of 100 other varieties was studied in observation plots.

(i) In the 85-100 days duration trial, 8 Chinese varieties and 6 improved strains, including the new selection B.76-1, were tested against the standard *Benibhog*. Four of the strains viz., PTB. 10, B.76-1, Adt.20 and Ch.45, in the order named, yielded significantly more than *Benibhog*. The selection B.76-1, which yielded 11.3 per cent. more than *Benibhog*, outyielded *Benibhog* by about 13 per cent. last year.

The selection B.76-3, reported 6.8 per cent. better than *Benibhog* last year was tested in another trial this year and yielded 10.6 per cent better than *Benibhog*.

(ii) In the 110-125 days duration trial, 36 varieties were tested against the standard T.635. Of the varieties tested Chinese variety viz., Ch.48 gave the highest yield, while the performance of two other varieties viz., TR.3 and Co.21 was also promising. These varieties will be further tested during the next season.

(iii) In the 125-140 days duration trial, 25 varieties were tested. The performance of T.1145, the standard variety for this duration due to sterility and poor setting was poor this year. Therefore the performance of the varieties was compared against SLO.6, a variety which for the past three years has given consistently higher yields than T.1145. Five of the varieties, viz., Bk.6, T.1850, T.874-1-9-2, T.588 and T. 141 yielded significantly more by 9 to 15 per cent. than the control.

(iv) In the 150-160 days duration trial, 20 varieties, were tested against the standard T.1242. Three varieties, MTU.10, T.2095 and SR.26B gave higher yields than the control but the difference was not significant. Variety BAM. 9, which gave satisfactory yield during the previous seasons, yielded slightly less this year.

(v) In the over-170 days duration trial 16 varieties were tested. Only one variety viz., Co.19 yielded higher (8.2 per cent.) than the local variety T.1242 but the difference was not significant.

(vi) In the second crop varietal trial 49 early maturing varieties were tested against PTB.10 as standard. Though none of these varieties yielded significantly higher than the control, 18 of them were found to be as good in yield as PTB.10.

Varieties and manures.—The response of nine varieties of 110-125 days duration to manuring was tested under different levels of manuring viz. (i) no manure, (ii) 30 lb. N, 40 lb. P_2O_5 , and (iii) 60 lb. N, 40 lb. P_2O_5 . The data are given in Table I below :

TABLE I
Yield of grain in lb. per acre

Variety	No manure (M_0)	30 lb.N 40 lb P_2O_5 (M_1)	60 lb.N 40 lb. P_2O_5 (M_2)	Response to M_1 (M_1-M_0)	Response to M_2 (M_2-M_0)
Benibhog	1510	1911	2345	401	835
B. 76-1	1748	2238	2426	490	678
Ch. 2	1054	1125	1254	71	200
Ch. 45	1367	1880	2009	513	742
N. 136	1229	1818	1961	589	732
T. 608	1515	1583	1785	68	270
Adt. 9	1265	2023	2507	758	1242
M.T.U. 9	1791	1902	2404	111	713
Adt. 15	1755	2120	2140	365	385
Mean	1470	1844	2092	374	622

C.D. (.05) for levels of manuring = 104 lb.

C.D. (.05) for response = 497 lb.

All varieties showed significant response in yield to manuring which increased linearly. There was differential response of the varieties to manuring and the manure $\times$ varieties interaction was significant. The highest response was obtained with variety Adt.9 and the least with varieties Ch.2 and T.608. In the previous years, as already reported, no differential response to manuring was found. The investigation will be continued to compare the results obtained this year.

B—CULTURAL TRIALS.

Crop sequence experiment.—The previous years' findings, that the inclusion of groundnut crop in sequence with rice benefits the succeeding rice crop besides giving a good economic return, were further confirmed this year. As reported last year the groundnut crop grown

in the *rabi* season gave a yield of 2044 lb. per acre, the rice crop following the groundnut crop in the *kharif* season of this year gave a yield of 1573 lb. per acre as against the yield of 1420 lb. from the crop sequence, rice followed by rice, thus giving an increase of 11 per cent. The inclusion of groundnut crop in the sequence benefits the succeeding rice crop as well as gives a good economic return.

Herbicides for weed control.—The efficacy, time of application and dosage of four herbicides *viz.*, Chloroxone (2, 4-D), Phenoxylyene 30 (MCPA), TCA.90 and 2,4,5-T for controlling weeds in rice fields were investigated in a preliminary experiment during the year. The results indicate that single spraying four weeks after transplanting of Phenoxylyene 30 at 2/3 gallon per acre and Chloroxone at 2 lb. per acre was as effective as hand weeding.

C—MANURIAL TRIALS.

(i) *Efficiency of different nitrogenous fertilizers for rice.*—This experiment, now in its 4th year, was continued with five nitrogenous fertilizers (ammonium sulphate, ammonium nitrate, ammonium phosphate, ammonium chloride and urea), tested at 20 and 40 lb. N per acre on varieties T.1145 (140 days duration) and T.90 (160 days duration). The results are given in Table II below :

TALBE II

Yield of grain in lb. per acre

Variety	T. 1145		T. 90	
Fertilizer	Nitrogen level Lb./Acre			
	20	40	20	40
Ammonium phosphate	1595	2000	1855	2227
Ammonium sulphate	1439	2078	1813	1990
Ammonium chloride	1507	1853	1700	1984
Urea	1354	1735	1662	2071
Ammonium nitrate	1340	1839	1756	1843
Mean	1447	1901	1757	2023
No manure (control)	1013		1541	

The yield increase was significant in both the varieties for all the forms of fertilizer and the response was linear. Among the fertilizers ammonium phosphate and ammonium sulphate gave the best response, followed by ammonium chloride and urea. With ammonium nitrate the response was significantly lower than ammonium phosphate.

(ii) *Residual effect of nitrogenous fertilizers.*—The area under the experiment on the comparative efficacy of nitrogenous fertilizers last season was cropped uniformly with variety T.1145 to investigate if the fertilizers had any residual effect. The results are given in Table III below :

TABLE III
Yield of grain in lb. per acre

Fertilizer treatment of previous year	Levels of nitrogen lb. per acre (previous year)		Mean
	20	40	
Ammonium phosphate	1969	2102	2035
Ammonium sulphate	1906	1948	1927
Ammonium nitrate	1832	1916	1874
Urea	1906	1827	1866
No manure (control)	..	..	1882
Mean	1903	1948	

The results show that none of the fertilizers had residual effect. There were no significant differences in yield between the various treatments.

(iii) *Placement and application of ammonium sulphate in split doses for the rice crop.*—Investigations during the past 3 seasons have proved the superiority of sub-surface application of ammonium sulphate in dry soil conditions over the customary surface application at the time of planting. Investigations were initiated during the year, under both upland and lowland conditions, to study the placement of fertilizers in split doses at different stages of plant growth.

The treatments were as below :

Levels of ammonium sulphate :—

1. No manure
2. 20 lb. N/A
3. 40 lb. N/A

The fertilizer was applied at one dose or $\frac{1}{2}$ at planting and the balance in 2 equal doses, one a month after planting and the second before flowering.

Method of application :—

1. Customary surface application.
2. Sub-surface dry application.
3. Sub-surface application in the form of pellets.

Time of application :—

1. Before planting.
2. At planting.
3. One month after planting.
4. One month before flowering.

The results are given in Table IV below :—

TABLE IV
Yield of grain in lb. per acre

Treatments	Upland variety (T.1145)		Low land variety (T.1242)	
	Nitrogen level lb. per acre			
	20	40	20	40
1. No manure (control)	943		1895	
2. Surface application at planting	1267	1284	2073	2259
3. Surface application one month after planting	1165	1032	2395	2226
4. Sub-surface dry application	1316	1470	2266	2592
5. Sub-surface pellet application at planting	1274	1477	2266	2393
6. Sub-surface pellet application one month after planting	1039	1171	2273	2325
7. $\frac{1}{2}$ sub-surface dry + $\frac{1}{2}$ surface one month after	1309	1277	2148	2355
8. $\frac{1}{2}$ sub-surface dry + $\frac{1}{2}$ pellet one month after	1274	1229	2289	2242
9. $\frac{1}{2}$ surface + $\frac{1}{2}$ surface one month after	1161	1387	2198	2393
10. $\frac{1}{2}$ surface + $\frac{1}{2}$ pellets one month after	1242	1135	2325	2116
11. $\frac{1}{2}$ surface + $\frac{1}{4}$ one month after + $\frac{1}{4}$ one month before flowering	..	1348	..	2310
12. $\frac{1}{2}$ sub-surface dry + $\frac{1}{4}$ one month after + $\frac{1}{4}$ at flowering	..	1380	..	2507
13. $\frac{1}{2}$ sub-surface + $\frac{1}{4}$ pellets one month after + $\frac{1}{4}$ pellets at flowering	..	1216	..	2337
Mean	1227	1288	2247	2338
C. D. (.05) for comparison of treatment within nitrogen levels	245.6		291.5	

All the manurial treatments have given increased yields though the response beyond 20 lb. N/A is small except in case of sub-surface application. Sub-surface application, both in dry soil condition and as pellets, has given the best response for upland as well as low land conditions. The responses for different methods of application are given in Table V below :

TABLE V
Response to ammonium sulphate application.—Yield of grain in lb. per acre

Method of application	Upland		Lowland	
	Level of Nitrogen lb. per acre			
	20	40	20	40
Surface application	324	341	178	364
Sub-surface dry application	373	527	371	697
Sub-surface pellet application at planting	331	534	371	498

As regards time of application, sub-surface dry application before planting or pellet application after planting appear to be the best. In the low land experiment, the application of entire quantity of ammonium sulphate one month after has given a substantial increase in yield at 20 lb. N/A, which is comparable with dry sub-surface application but with the increase in level of application this superiority is not maintained.

The application of ammonium sulphate in split doses on equal nitrogen basis at different periods of plant growth does not give any increased response. None of the combinations have given higher yield than the application of the entire quantity in one dose as sub-surface dry application.

(iv) *Long range manurial trials.*—These experiments, as previously reported, are designed to investigate the cumulative effect of continuous application of various fertilizers and manures on the condition and productivity of rice soils. However, the soil studies have not yet been taken up due to want of laboratory facilities.

(a) *Ammonium sulphate with and without lime and compost.*—This experiment on the effect of continuous application of ammonium sulphate in rice soils with and without application of lime, which has been in progress for the past 5 years, was slightly modified this year to include application of organic matter as compost at the rate of 100 mds. per acre in conjunction with ammonium sulphate and lime. The data are given in table VI below :

TABLE VI
Yield of grain in lb. per acre

Lime/Cwt. per acre	No compost			Compost (100 mds.) per acre			General mean
	Ammonium sulphate			Nitrogen level lb. per acre			
	0	20	40	0	20	40	
0	1683	2045	2388	2028	2297	2493	2155·5
4	1569	1864	2329	2000	2126	2278	2027·7
8	1636	2012	2224	1855	2379	2348	2075·7
Mean	1629·3	1973·7	2313·7	1961	2267·3	2373	

C.D. (.05) = 208·16

As in the previous years the application of lime, either alone or in combination with ammonium sulphate, had no effect on the yield. In conjunction with compost lime has also no effect. The application of compost gave significant yield response. The interaction between ammonium sulphate and compost was significant, indicating a differential response. While in the absence of basal dressing of compost, the ammonium sulphate gave a linear response, upto 40 lb. N/A, with basal dressing of compost it gave significant increase in yield upto 20

lb. N/A and with additional dose the increase is slight and not significant. The data averaged over the lime treatments are given in Table VII below :

TABLE VII
Yield of grain in lb. per acre

Ammonium sulphate N/A	Compost md. per acre)		Mean
	0	100	
0	1629	1961	1795.1
20	1974	2267	2120.5
40	2314	2373	2343.3
Mean	1972.2	2202.7	

C.D. (.05) for nitrogen application=208.16

C.D. (.05) for treatment combinations=191.60

C.D. (.05) for compost application=256.10

(b) *Ammonium sulphate with and without compost.*—This experiment has now been in progress for the past four years. The results obtained this year are given in Table VIII below :

TABLE VIII
Yield of grain in lb. per acre

Ammonium sulphate N/A	Compost (md. per acre)		Mean	C.D. (.05)= 224.35
	0	100		
0	1864	2052	1958	
20	1919	2419	2169	
40	2099	2328	2214	
60	2287	2222	2254	
80	2110	1702	1906	
Mean	2055.8	2144.6		

C.D. (.05)=165.6

The response in general was low due to adverse climatic conditions. Nitrogen in the form of ammonium sulphate increased the yield upto 60 lb. N/A after which the yield declined. In plots with basal dressing of compost, the yield increased only with 20 lb. N and declined with increased dose of nitrogen. At 80 lb. N/A the yield was actually less than the control.

As in the previous year the yield-nitrogen level relationship can be represented by the quadratic curve, for both compost and no compost plots, and is given by the following equations :—

$$\text{No compost} \quad . \quad . \quad . \quad Y = 1863.8 + 346.8 X - 77.9 X^2$$

$$\text{Compost} \quad . \quad . \quad . \quad Y = 2106.9 + 337.5 X - 115.6 X^2$$

When Y is the mean yield per acre and X is the nitrogen level per acre, each unit being of 20 lb. N. From the yield-nitrogen quadratic function it will be seen that the maximum yields of 2353 and 2291 lb. per acre are obtained by the application of 30 and 47 lb. of nitrogen per acre in case of compost and no compost plots respectively. These also indicate a greater rate of decline in yield for compost treated plots with increase in the nitrogen level beyond the dose corresponding to maximum yield.

(v) *N. P. K. experiment.*—This experiment, now in its 4th year, is designed to investigate the suitable combinations of the three major plant nutrients and determine their relative performance with basal dressings of various organic manures. As in previous years the fertilizers were applied at 3 levels *viz.*, 0, 20 and 40 lb. N, P_2O_5 and K_2O with basal dressings of organic manures to supply 20 lb. N/A.

Significant increases in yield were obtained by application of ammonium sulphate at 20 lb. N/A and with basal dressing of compost and by top dressing of ammonium sulphate at 40 lb. N/A. The yield data are given in Table IX below :

TABLE IX
Yield of grain in lb. per acre.

Top dressing Ammonium sulphate N/A	Basal dressing					
	No Manure	Compost	Ground-nut cake	Dhanicha	Mean	
0	1921	2045	2054	1984	2001	C.D. (.05) =107.16
20	2133	2326	1924	2169	2136	
40	2302	2258	1811	2065	2109	
Mean	2119	2209	1930	2073		

C.D. (.05) = 260.68

Neither the phosphate nor potash application was found to have any effect on yield, whether applied alone or in conjunction with nitrogen or the basal dressing of organic manures as will be seen from the Table X given below :

TABLE X
Yield of grain in lb. per acre

					K_0	K_{20}	K_{40}	Mean
P_0					2122	2071	2054	2082
P_{20}					2098	2083	2118	2099
P_{40}					2050	2015	2117	2061
Mean					2090	2056	2096	

STATISTICS

In addition to helping the different research divisions in the design of experiments and interpretation of results, the following investigations were carried out—

I. *Sampling studies*.—Investigations on sampling in field experiment were conducted for estimating yield, tillers and height, using different types and sizes of sampling units. The results obtained are given below :—

(a) *Size of sampling unit and sampling variance*.—It was found that for all characters, with increase in the size of sampling unit from 1 sq. ft. to 9 sq. ft. the logarithm of the corresponding sampling variance decreased linearly, the rate of decrease being about 0.52, 0.84, and 0.36 respectively. From this it follows that contiguous units show maximum correlation for height, and least for number of earheads.

(b) *Comparison of different types of sampling unit*.—Comparing square units with the type of sampling units adopted for crop-weather scheme experiments, linear units, and random plants, it was found that with a given percentage sampling the random plant units generally gave higher precision, but for yield and tillers, the differences were small. Hence for these two characters the type of sampling unit can be chosen according to practical convenience without much loss in efficiency. However, for estimating height, units consisting of contiguous plants were found to be efficient.

For all characters, random plants and plants systematically taken along the rows were found to give practically same result.

(c) *Optimum sampling units*.—With due consideration on the time taken and labour involved, a sampling unit of 4 to 6 sq. ft. was found best for yield and tillers while for height a sub-sample of 4 plants from the primary unit was found sufficient.

II. *Border effect*.—Preliminary investigations from field experiment data showed that the first one foot border gave considerably higher yield (about 30 to 50%) over the central area of the plots, presumably due to the vacant space left between the plots. The coefficient of variation did not show any difference.

III. *Estimation of relative efficiencies of fertilizer forms*.—Equations of the form, $Y = a + bx + cx^2$; $Y = a + bP_1x + CP_1^2x^2$ and $Y = a + bP_2x + CP_2^2x^2$ were used to describe the response curves obtained with ammonium sulphate, ammonium nitrate and urea, at the Central Rice Research Institute for the past four years. In the equations P_1 and P_2 give the relative efficiencies of ammonium nitrate and urea compared with ammonium sulphate, relative efficiency being defined as the inverse ratio of the amount of nutrient required to give equal response. Estimates of P_1 and P_2 were obtained by the maximum likelihood method and were found to be 0.53 and 0.67 respectively for ammonium nitrate and urea.

IV. *Optimum allocation in progeny row trials.*—In progeny row trials with 100 to 150 progenies the experimental error has been found to be about 20 to 22%. On the basis of this value and the usual amount of genetic variability expected in natural populations, it is found that with a given experimental area, the estimates of the genetic variability component will be obtained with maximum precision, when the number of replications is limited to about four to six and number of progenies proportionately increased.

BOTANY

I. *Maintenance and study of genetic stocks.*—During the year 94 additions, consisting of 70 foreign and 24 Indian types, were made to the genetic stocks maintained at this Institute. The foreign additions were from Philippines, Malaya, Taiwan, Indonesia, Indo-China, Africa and Burma. Seed samples of 338 types from the collection were sent out in response to requests received from abroad and States in India.

In the field, the collection was studied for duration, agronomic and morphological characters. Special attention was paid this year to non-lodging character. Twenty types in the collection were found to be non-lodging and the performance of these types under heavily manured conditions will be studied next year. In the laboratory the types were examined for size of grain, rice colour, endosperm character etc. On the basis of preliminary observations 179 types have been chosen for trial in the coming season.

D.S.I., a variety from Swaziland, reported to be heavy yielder with good ratooning capacity was received late in the season and was therefore grown in the second crop season. This variety matured in 102 days, was poor in yield and very susceptible to *Piricularia* and stem borer. The variety will, however, be tested again during the next crop season. A dwarf mutant isolated in type 1222-12 in the collection is being carried forward for genetical investigations.

II. *Improvement of yield by (i) Introduction.*—The yield performance of 104 types from the genetic stocks was studied during the year with suitable controls. 88 of these types were tested for the first time, while 11 were brought forward from the trials conducted last year. The types were grouped according to duration and were tested in the following 7 replicated randomised trials:

- (i) 101-120 days duration trial with 5 types and 3 controls.
- (ii) 121-130 days duration trial with 5 types and 2 controls.
- (iii) 131-140 days duration trial with 6 types and 1 control.
- (iv) 141-150 days duration trial with 11 types and 1 control.
- (v) 151-160 days duration trial with 34 types and 2 controls.
- (vi) 161-170 days duration trial with 34 types and 2 controls.
- (vii) 171-180 days duration trial with 9 types and 3 controls.

In the 101-120 days trial four of the types yielded significantly higher than the controls. In the 121-130 days trials none of the types were found to be superior to the controls. In the 141-150 days trial varieties, *Vellai Ilankalayan* (Ceylon), U.S.A. 3, EC. 2706 (Australia) T.704, S.M.4 (Siam) Y.5109 (Australia) and T.859 were found to be significantly superior in yield to the control T.1145, but the last four varieties were a week to fortnight later in maturity than T.1145. In 151-160 days duration trial, while none of the types were superior in yield to the control BAM. 9, four of the varieties *i.e.*, Jelly 192, T.388(U.S.A.), *Intan* (Indonesia) and Jelly 175 were significantly superior to the other two controls *i.e.*, T.90 and T.1242. In the 161-170 days duration trial none of the types were superior in yield to the control BAM9 while 6 types, *i.e.*, AC.2648, AC.1230, AC.2616, AC.452, AC.2734 and AC.2543 were superior in yield to the control AKP.11. In the 171-180 days duration trial none of the types were superior in yield to the controls Co.16 and Adt.10. The types found superior in yield to the controls in these trials are being carried forward for further trials next year.

(ii) *Hybridization.*—(a) *Between japonica and indica races of rice.*—As has been previously reported extensive hybridization is being carried out at this Institute between the two geographical races of rice, under schemes sponsored by the FAO and the I.C.A.R. for benefit of several South-East Asian countries including India and rice growing States of India respectively.

The object of these schemes is to evolve strains with high yield and good response to fertilizers characteristic of the *japonicas* with the adaptation to tropical conditions of the *indica* rices. The concerned Asian countries and Indian States have selected and sent to Cuttack their important varieties for carrying out hybridization with the *japonicas*. The crosses are being made here and material for growing the F_2 generation is being sent to the respective countries and States for making the necessary selections. During the year 1,43,400 cross pollinations were done and 13,260 crossed seeds collected. Besides, this 26,627 back crosses to *indica* parents of 97 cross combinations were done and 1,632 back crossed seeds collected.

F_1 generation of 400 cross combinations, consisting of 7,500 plants, was grown and studied for flowering duration, tillering, vigour, height, pigmentation, pollen and spikelet sterility. The hybrids were very vigorous in growth, as tall as the *indica* parents, with more tillering than either parents and in flowering duration were later than the *Japonicas* but earlier than the *indica* parents.

The hybrids showed varying degree of pollen and spikelet sterility. Pollen and spikelet sterility were found to be positively correlated, spikelet sterility being higher than pollen sterility. The mean spikelet sterility in the various combinations varied from below 10 per cent. to over 90 per cent. It was found that in general the reciprocal crosses did not show such difference in degree of sterility; the difference in majority of

cases being less than 10 per cent. However, in some cases the difference in degree of sterility between the reciprocals was over 10 per cent. and in such cases, the sterility was found to be more when the *japonica* was used as the female parent.

Approximately 30 lakh seeds, from the F_1 generation of the various cross combinations grown during the year, were sent to 16 States in India and 9 South-East Asian countries for growing the F_2 generations.

F_2 generation of 79 cross combinations were grown and studied. Cross combinations in which sufficient seed was available, were also grown under heavy manuring and under upland conditions.

In the F_2 population, a wide variation was observed with regard to duration, spikelet sterility, plant height, number of ear-bearing tillers, grain size vigour etc. The F_2 population ranged from small, stunted plants with one or two tillers to tall vigorous plants with over fifty ear-bearing tillers.

About 3,000 field selections were made in the F_2 population on the basis of ear-bearing tillers, early maturity, low spikelet sterility, vigour and non-lodging character. The yield of these plants was determined and about 1,300 selections were finally retained for further study.

(b) *Within indica group of rice.*—As has been previously reported, this project has been undertaken to breed early maturing, high yielding strains. During the year F_3 generations of 232 selections coming from the following 10 cross combinations were grown :—

Cross combination	No. of selections
1. T.1145 $\times$ <i>Sathika</i>	35
2. T.1145 $\times$ Ch.2.	16
3. T.1145 $\times$ T.1031	91
4. T.812 $\times$ <i>Sathika</i>	2
5. T.812 $\times$ T.1031	4
6. T.1242 $\times$ <i>Sathika</i>	9
7. T.1242 $\times$ T.1031	33
8. T.90 $\times$ <i>Sathika</i>	13
9. T.90 $\times$ T.1031	22
10. BAM.9 $\times$ <i>Sathika</i>	7
	232

High spikelet sterility was noted in the progenies due to which plot yields could not be compared. The sterility was probably due to the heavy rains at the time of flowering which interfered with the setting. Selection was confined to early maturing plants, *i.e.*, flowering within 90 days of sowing and on the basis of the number of ear-bearing tillers, 2,986 field selections were made, out of which 385 selections based on plant yields were finally retained.

III. *Breeding for high fertility soil conditions.*—With the present emphasis on intensive cultivation there is need for varieties which can utilise to the best advantage the rich soil conditions given. With a view, therefore, to determine varieties suitable for growing under heavily manured conditions, a preliminary investigation was made of the performance of 465 types from the collection of genetic stocks. The types were grown in 2 row plots of 42 plants each manured with—

- (1) Basal dose of compost to give 40 lb. N per acre.
- (2) 50 lb. P_2O_5 as super phosphate.
- (3) 60 lb. of N as ammonium sulphate applied in 3 equal doses 2, 5 and 7 weeks after planting.

All the varieties tested put up rank vegetative growth and lodged completely. On examination of the mean single plant yield of these types grown under ordinary soil condition in the type collection plots, and under the heavily manured conditions prevailing in the experiment, it was found that the types could be grouped into 3 classes *viz.*, (i) types which respond to manuring, (ii) types which do not respond to manuring the yield being about the same under both conditions, and (iii) types in which the yield actually decreased with manuring. The increase or decrease in yield ranged from 10 per cent. upto cent per cent. The performance of 65 of these varieties will be further tested under normal and heavily manured conditions next year.

As has been mentioned earlier, F_2 generation of some of the *Japonica* $\times$ *indica* cross combinations was also grown under heavily manured conditions. From this material 868 field selections were made, out of which 228 selections based on plant yield have been finally retained.

IV. *Breeding for upland conditions.*—A large proportion of the rice crop is cultivated under purely rainfed conditions and it is necessary to find out varieties suited for growing under such conditions. With this view a preliminary investigation of the performance of 376 short duration types (maturing within 120 days of sowing) from the collection of genetic stocks was undertaken. The types were sown in unreplicated single row plots. The flowering duration of the varieties was found to be a few days earlier than under wet land conditions. The mean plant yield of the types under upland conditions was generally very much lower than under wet land conditions. Based on the yield performance 46 of these varieties being carried forward for further trial.

As has been mentioned earlier, F_2 generation of some of the *japonica* $\times$ *indica* cross combinations was also grown under upland conditions: 928 field selections were made in this material, out of which 227 selections have been finally retained.

V. *Secondary selections.*—As has been previously reported an investigation is in progress to study genetic variability and to determine the value and scope of secondary selections in rice breeding. This year the study involved (a) trial of secondary selections coming from T.1222-12 material, (b) small bulk trial with T.1222-12 material, (c) trial of

secondary selections made in Adt.4,(d) trial of secondary selections made in Adt. 20,(e) trial of secondary selections made in variety *Chinamali*, (f) trial of primary selections made in BAM. 9, an improved variety of Orissa State, and (g) making first selections in *Suruchina*, a cultivator's variety.

(a) *Trial of T.1222-12 secondary selections.*—As has been reported previously, significant differences in yield were found to be present, even after four years of continuous selection, within the families 116-30 and 116-88 of T.1222-12 material. Further selections made in the progenies of these families were, therefore, carried forward and tested this year in a compact family layout, consisting of 15 families with 6 progenies in each along with T.1222-12 original bulk in 6 replications. The bulk plots flowered 4-5 days earlier than the selections, it would thus appear that along with better yield, selection has been in the direction of slightly later duration plants. After flowering high sterility was observed and extent of the same was from 50 to cent per cent. due probably to heavy rains during flowering. No yield data could therefore be recorded and the selections carried forward.

(b) *Small bulk trial of T.1222-12 material.*—Small bulks of the progressive selections made in T.1222-12 during the first four years were tested in a replicated randomised plot layout. The flowering duration of the selections was slightly later than the bulk showing a gradual increase in duration of the selections as shown below :—

Family	Mean flowering duration
T.1222-12(bulk)	105.3 days.
T. 222-116	106.3 "
T.11222-116-30	108.7 "
T.1222-116-30-58	113.8 "
T.1222-116-30-58-129	113.7 "
T.1222-116-30-106	112.6 "
T.1222-116-30-106-39	114.3 "
T.1222-116-30-127	106.8 "
T.1222-116-30-127-39	112.3 "
T.1222-116-88	112.3 "
T.1222-116-88-62	108.7 "
T.1222-116-88-62-21	112.2 "

In this trial also considerable sterility of the spikelets was found particularly in the bulk and the earlier flowering selections, the later flowering selections escaped to some extent the heavy rains and the sterility in these selections was not so marked. Under these circumstances yield data was incomplete and no analysis could be done.

(c) *Trial of Adt.4 secondary selections.*—As has been reported significant differences in yield between the first selections of Adt.4 were found in last year's progeny row trial. Secondary selections made in this material were carried forward and tested in a compact family layout consisting of 15 families with 6 progenies in each against the original bulk. The yield differences between the families just fell short of significance; this was probably due to the high S.E. of 5.1 per cent. as against the 3 per cent. usually obtained in such trials. However, examination of the mean yields of the families showed that all the

selections yielded better than the original bulk and that the best families *i.e.*, 80 and 91, yielded about 25 per cent. better than the original bulk. In the within family comparison, 7 out of the 15 families showed significant differences in yield between the progenies and further selections made in the progenies are therefore being carried forward.

(d) *Trial of Adt.20 secondary selections.*—The secondary selections brought forward from Adt.20 progeny row trial of last year, were tested in a compact family block layout consisting of 15 families with 6 progenies in each against the original bulk. Significant differences in yield between the families were found. Three families proved to be significantly superior in yield than the original bulk by about 14 per cent. In the within family comparison, in 6 out of the 15 families significant differences in yield between progenies were found. Further selections made this year in the material are being carried forward for study.

(e) *Trial of Chinamali secondary selections.*—As has been reported last year significant differences in yield between progenies of 5 families were found, three of these families were as good as *Chinamali* bulk in yield while the remaining two families *i.e.*, 336 and 535 were superior. Secondary selections made in these five families were therefore carried forward and tested in a compact family layout against the *Chinamali* bulk. No significant differences in yield between the families or within a family were found this year.

(f) *Trial of BAM.9 first selection.*—99 selections made last year in variety BAM.9 were tested in a progeny row trial. No significant differences in yield were found between progenies, showing lack of sufficient genetic variability, consequently no further selections were made in this material.

(g) *Selections in Suruchina.*—520 random progeny selections were made in *Suruchina* to study genetic variability and scope of improvement of this local variety.

VI. *Genetics* : (a) *Pigmentation.*—In hybrids between some green *japonicas* and green *indicas*, while parts like leaf blade, leaf axil and lemma and palea were found to be green, certain other plant parts like leaf sheath, auricle, ligule, junctura, apiculus and stigma were pigmented, showing that complementary genes were involved for production of pigmentation in these parts. In crosses within each group of these green *japonicas* and *indicas*, the hybrids were pure green, thus indicating that all the *japonicas* involved in the experiment carried the same complementary gene and the *indicas* the second complementary gene.

In a cross between T.636, a pure green type, and T.141 a type with pigmentation in auricle, ligule, glume, apiculus and other parts, the occurrence of pigmentation in apiculus, glume and auricle was found to be controlled by single factor pairs giving 3 pigmented : 1 non-pigmented, while in the case of ligule two genes were concerned in

the production of pigmentation, giving 9 pigmented : 7 non-pigmented in this cross. The joint segregation of the characters was examined and the following linkage relationships were established :—

Between apiculus colour and glume colour with crossing over value of 1.2%.

Between ligule colour and glume colour with a crossing over value of 5.67%.

Between auricle colour and glume colour with a crossing over value of 7.6%.

Between apiculus colour and auricle colour with a crossing over value of 8.4%.

(b) *Awning*.—An inhibitor gene was found to affect the expression of awning in a cross between C.28-16 an awnless *indica* type from Burma, and *Aikoku*, a fully awned *japonica* type. The F_1 proved to be awnless and the F_2 segregated into 13 awnless : 3 awned.

(c) *Spikelet sterility*.—As has been stated earlier in the report the *japonica*—*indica* hybrids show varying degrees of spikelet sterility. The behaviour of three F_2 families with regard to sterility was investigated. These three F_2 families were drawn from low, medium and high sterility groups in the F_1 s. The data are presented in Table XI below :

TABLE XI

Cross combination	Sterility percentage in F_1	F_2 population	Range of sterility percentage in F_2	C.V.	Percentage of F_2 plants within 50% sterility
Mo.2 × <i>Thaihoku</i> 6	25.0 (low)	795	20-100	37.0	49.8
<i>Asahi</i> × <i>Waner</i> 1	47.8 (medium)	785	15-100	42.9	54.1
T.1145 × <i>Taihoku</i>	79.6 (high)	394	15-100	39.4	60.9

It will be seen that irrespective of the degree of sterility in the F_1 the range of sterility in three F_2 families was practically the same and the co-efficient of variability was of the same order. It would thus be seen that there were equally good chances of obtaining fertile selections from population derived from F_1 s having high sterility as from more fertile F_1 s.

(d) *Grain size*.—The F_1 , F_2 and F_3 generations and the parents were grown simultaneously in one layout. From each plant on 10 random grains, length, breadth and thickness measurements are being recorded and the data remain to be analysed.

VII. *Physiology*.—The response of 10 early duration varieties to drought and the stage at which the plants were most susceptible were investigated in a preliminary pot experiment. Starting with 10 days

after germination watering was stopped for 20 days at a stretch in a set of pots at five successive stages of growth of the plants. The data of mortality in the various treatments are given in Table XII below :

TABLE XII

Plant mortality at different stages of growth due to drought

Variety	Drought Periods					Total	Control (Mortality)
	10-30 days after germination	31-50 days after germination	51-70 days after germination (Initiation of flower primordia)	71-90 days after germination (Ear emergence)	91-110 days after germination (Full flowering)		
1. Ch.45	1	1	5	5	1	13	..
2. Ac.115 (As.3)	.	1	3	6	5	15	2
3. Ac.239 (H.S.19)	1	1	7	6	5	20	3
4. Ac.256 (Adt.4)	..	5	6	7	4	22	..
5. Ac.424 (T.380)	..	5	8	7	2	22	..
6. Ac.499 (T.21)	1	1	8	6	4	20	..
7. Ac.214 (Str.141)	2	5	8	5	3	23	..
8. Ac.2260 (Waner.1)	1	3	5	5	3	17	3
9. Ac.2264 (100 R. <i>Jawain</i>)	1	3	6	6	5	21	..
10. Ac.2272 (R ₂ <i>Nungi</i>)	3	2	4	4	2	15	6
TOTAL	10	27	60	57	34	..	16

It was found that in the earlier stages the plant could stand drought condition better than in the later stage of growth. The plants were most susceptible to drought at the initiation of flower primordium and ear emergence stages. Plant mortality was highest at these stages *vide* table given above. Drought appeared to prolong the flowering duration slightly and affect the height and tillering of the plants adversely as compared with the control. As will be seen from the table given above, varieties Ch.45, As.3 and R₂ *Nungi* appear to be relatively more resistant to drought than the other varieties.

Photoperiod response of rice varieties.—The response of 20 rice varieties from 8 different Asian countries was investigated under photoperiods of $10\frac{1}{2}$, $11\frac{1}{2}$, $12\frac{1}{2}$ hours and natural day length. The data are given below in Table XIII :

TABLE XIII

	Early varieties				Late varieties			
	Photoperiods (Hrs.)				Photoperiods (Hrs.)			
	$10\frac{1}{2}$	$11\frac{1}{2}$	$12\frac{1}{2}$	Control	$10\frac{1}{2}$	$11\frac{1}{2}$	$12\frac{1}{2}$	Control
	Days				Days			
Flowering primordium Initiation	38·1	44·0	53·0	65·8	79	88	162	127
Initiation to ear emergence	16	16	17	16	16	16	15	15
Ear emergence	54	60	69	78	95	104	178	142
Commencement of blooming	55	60·5	70	82	94	107	178	143
Completion of blooming	70	76	86	98	108	123	197	161
	Cms.				Cms.			
Panicle length	13·3	14·4	15·4	17·0	15	19	20	16
Plant height	67·0	77·1	78·4	88·3	80·5	92	92	80
	Number				Number			
Total tillers	6	6	7	5	5	6	8·5	5·6
Ear bearing tillers	3·5	4·7	4·3	3·1	3·3	3·7	5·3	3·2

It was found that both in early and late varieties, with the increase in photoperiod, the initiation of flower primordium, ear emergence, commencement and completion of blooming was delayed. Compared, however, to the control plants in the early varieties group the flowering duration was hastened by the photoperiods, while in the case of late varieties the flowering duration was hastened in the $10\frac{1}{2}$ and $11\frac{1}{2}$ hrs. photoperiods and in the $12\frac{1}{2}$ hrs. photoperiod it was delayed. This was probably due to the natural day length being shorter than $12\frac{1}{2}$ hrs. from about the middle of October to the end of January.

There was an increase in the length of panicles with the increase of photoperiods from $10\frac{1}{2}$ to $12\frac{1}{2}$ hrs. in both early and late groups. When compared to the panicle length of the control plant, the length of the panicles was shorter in the early varieties while in the case of the late varieties it was somewhat longer. With regard to plant height there was an increase in the height of the plant of the early group with the increase in photoperiods from $10\frac{1}{2}$ to $12\frac{1}{2}$ hrs. but the control plants were taller. In the case of late varieties there was an increase in plant height from $10\frac{1}{2}$ to $11\frac{1}{2}$ hrs. photoperiod and no increase between $11\frac{1}{2}$ to $12\frac{1}{2}$ hrs., while the control plants were definitely shorter than $11\frac{1}{2}$ to $12\frac{1}{2}$ hrs. photoperiod but about equal to $10\frac{1}{2}$ hrs. photoperiod plants.

Photoperiod had no effect on the time taken from initiation of flower primordium to ear emergence. While increased photoperiod generally increased the number of tillers (ear bearing and total) in the late group its effect on the early varieties was irregular.

VIII. *Cytology*.—With the appointment of a Cytogeneticist under the Rice Hybridization Scheme sponsored by the FAO, the causes of sterility in *japonica*—*indica* hybrids are being investigated. Meiosis in pollen mother cells was observed in 27 semi-sterile hybrids. In all, the chromosome pairing was found to be regular. In many of the hybrids early separation of one, two or three bivalents were recorded at metaphase I, indicating low chiasma frequency. In 18 hybrids anaphase I and second division were regular. In 9 hybrids, anaphase I showed irregularities like “laggards” and anaphase ‘birdges’ with or without chromosome fragments in 3 to 41 per cent. of cells.

Meiosis in a few parent types was studied from panicles collected in the hot weather. In types Adt.12 and *Raikuu* 132 anaphase irregularities were found, as a result of the ‘stickiness’ of the chromosomes which is probably due to the season. Further comparison will be made in the normal rice growing season.

From the study so far made, it is inferred that the semi-sterility of the hybrids is not due to failure of chromosome pairing, or due to multi-valent formation. In some hybrids anaphase I irregularities are likely contributors to partial gametic sterility.

CHEMISTRY

1. *Laboratory investigations*.—Preliminary studies on nitrogen transformation in soil under water-logged condition was undertaken, and changes in $\text{NH}_3\text{-N}$ and $\text{No}_3\text{-N}$ status of soil in combination with bulky organic manures were followed up for a six-week period. A clay soil, from low lying water-logged area, was taken for study and organic manures were added at the rate of 25 parts of nitrogen per million parts of soil. A sharp increase in the $\text{NH}_3\text{-N}$ content of soil, after the first week and a gradual build-up later on, was observed during the period of study. The $\text{No}_3\text{-N}$ content of soil under water-logged condition, however, continued to decrease and after about three weeks of water-logging only traces $\text{No}_3\text{-N}$ could be detected. Among the organic manures studied the ease of decomposition and availability of $\text{NH}_3\text{-N}$ in the soil was in the order, green manure > groundnut cake > Bone meal > Compost. The results of six-week study are recorded in Tables XIV and XV below :

TABLE XIV
($\text{NH}_3\text{-N}$ parts per million of soil)

Treatments	Days of water-logging						
	Start	7 days	14 days	21 days	28 days	35 days	42 days
Soil+green manure	..	36	42	45	49	51	52
Soil+groundnut cake	..	31	37	41	45	47	48
Soil+Bone Meal	..	34	36	37	42	42	42
Soil+Compost	..	28	31	33	37	39	40
Soil (Control)	17	28	28	28	31	31	33

TABLE XV.

(No₃-N parts per million of soil)

Treatments	Days of water-logging						
	Start	7 days	14 days	21 days	28 days	35 days	42 days
Soil+green manure	..	7	5	4	2	2	1
Soil+groundnut cake	..	8	6	1	1	1	1
Soil+ Bone Meal	..	7	6	1	1	1	1
Soil+Compost	..	4	3	2	2	1	1
Soil (Control)	5	5	3	2	2	1	1

Further studies with different fertilizers and bulky organic manures and their combinations, at varying moisture levels and states of aeration are being undertaken.

II. *Field investigations.*—(1) *Seed soaking in nutrient solutions*.—Seed soaking trials started in 1948-49, with a view to see if yield could be increased by soaking seed in nutrient solution prior to sowing, were continued. In previous years treatment with 10% and 20% solutions of K₂HPO₄ had given yield increases of 8% to 10% over control. This year two large scale field trials with Co.13 (early duration variety) and T.141 (medium duration variety) respectively, were undertaken, using treatment with 10% K₂HPO₄ solution only. A yield increase of 9% over control yield of 913 lb. for variety Co.13 and 8% over control yield of 2,587 lb. for variety T.141 was obtained by this treatment. Increase was significant only in latter case with variety T.141.

(2) *Sub-surface (deep) placement of sulphate of ammonia fertilizer.*—Sub-surface placement of sulphate of ammonia under wet soil conditions, in the form of pellets, has been tried for the last three years and has given higher yields of both grain and straw, indicating an increased efficiency and higher availability of fertilizers by this mode of application. Experiment was again repeated this year with variety of paddy T.1242 (late duration) in a low lying water-logged soil using sulphate of ammonia at 20 lb. N per acre. Sub-surface application gave a 12% increase in yield, as compared to 6.5% increase given by surface application over a control yield of 2,639 lb. per acre.

(3) *Micro-nutrients for rice crop.*—To study if any of the micro-nutrients form a limiting factor in rice crop production and increase yield, a number of trials were laid out during the year, using soluble salts of micro-nutrients Mn, Zn, B, Mg. and Mo. Application of micro-nutrients to soil before sowing, treatment of seed with solutions of salts, prior to sowing and spraying of solution to standing crop were tried in preliminary trials. Application to soil and treatment of seed, did not result in any increased yield. In spraying trials, however, spraying of early variety Co.13 with CuSO₄ and ZnSO₄ each at 20 lb. in 100

gallons of water per acre, gave a small increase in yield, which was however, not significant over control. Results of spraying trials with this variety are given in Table XVI below :

TABLE XVI
Minor element spraying trials
(Mean yield in lb. per acre)

	Yield	Per cent.
Control	1067	100·0
CuSO ₄ 20 lb/acre	1207	113·1
MnSO ₄ 20 lb/acre	1042	97·7
ZnSO ₄ 20 lb/acre	1157	108·4
Borax 20 lb/acre	1052	98·6
MgSO ₄ 50 lb/acre	992	93·0
Ammo. molybdate 10 lb/acre	1067	100·0
C. D.	143 lb.	

(4) *Phosphatic manuring of paddy crop*.—A number of experiments were laid out to study the effect of phosphate application on the yield of paddy crop. A permanent phosphate manurial trial in pots (sunk *in situ*) to study the effect of continuous application of superphosphate of lime, started two years back, was also continued.

(a) In one experiment superphosphate application at 50 lb. P₂O per acre was done prior to sowing of a green manure crop (*dhaincha*), which in turn was ploughed in after five weeks growth and paddy crop transplanted. Phosphatic application increased the yield of green manure crop considerably, but no direct or indirect effect (due to incorporation of increased green matter obtained by phosphate application) on the yield of paddy crop could be observed.

(b) In another experiment superphosphate at 50 lb. and 100 lb. P₂O₅ per acre was tried in combination with lime and nitrogen application, but no effect due to phosphatic fertilization on the yield of the crop could be observed. This has been laid out as a permanent manurial experiment in which cumulative effect of phosphate application is to be studied.

(c) In pot experiment (pots sunk *in situ*) the effect of continuous application of superphosphate of lime at two levels in combination with lime applied every alternate year and sulphate of ammonia every year, has been under study for last two years. The experiment was continued this year. The results show a tendency for phosphate build-up due to continuous application. This year pots, receiving 100 lb. P₂O₅ per acre showed a significant yield increase of 12% over control. No

such significant yield increase due to phosphatic application was observable during the previous years. Results are given in Table XVII below. Experiment is to be continued for a few more years.

TABLE XVII
Yield of grain in gram per pot

	P ₀	P ₅₀	P ₁₀₀	Mean
N ₀	126·7	133·8	144·9	135·1
N ₂₀	142·7	152·7	156·9	150·8
Mean	134·7	143·2	150·9	..

C. D. for comparing nitrogen treatments mean=12 grams.

C. D. for comparing mean of phosphate treatments=15 grams.

(5) *Investigations on the need of liming paddy soils.*—Lime upto a rate of 1,000 lb. per acre has been tried in various experiments but the yield increase obtained has been small. A higher dose of 2,000 lb. per acre was therefore tried in one experiment along with phosphate and nitrogen treatments. The yield of grain obtained is given in Table XVIII below :

TABLE XVIII
Mean yield in lb. per acre

	N ₁	N ₂₀ surface	N ₂₀ deep	Mean
L ₀	2441 100·0%	2656 108·8%	2800 114·7%	2632 100·0%
L ₁	2836 116·2%	2965 121·5%	3105 127·2%	2969 112·8%

Lime on an average gave a yield increase of 12·8% over no lime yield of 2632 lb. per acre. Observations during the growth of crop showed that lime plots put up a far more healthier appearance and better growth than no lime plot, right upto the flowering period. Lime application to soil is known to increase microbiological activity resulting in release and accumulation of NH₃-H in the soil.

ENTOMOLOGY

A. FIELD PESTS

I. *Varietal susceptibility to Gall-fly (Pachytiplosis oryzae).*—(a) Work done during the previous years has clearly indicated that differences exist between varieties with regard to gall-fly incidence. The susceptibility of some 1,000 varieties to gall-fly was studied during the year and the data are now being examined and the varieties classified.

(b) The probability of correlation between morphological characters of the rice plant and gall-fly incidence was reported last year. This was further investigated this year with 20 varieties viz. 7 green non-scented, 8 green scented and 5 purple pigmented varieties. Random samples of these varieties were examined, at the peak period of gall-fly incidence (end of October), and it was found that in green non-scented the gall-fly incidence ranged from 16.9 to 26.9 per cent., in purple pigmented varieties the incidence was from 0.61 to 22.1 per cent. and among the green scented varieties it ranged from 2.8 per cent in *Jeeragasala* to 14.2 per cent. in *Raskadam*.

(c) The loss caused by the incidence of gall-fly was investigated in a preliminary trial. It was found that the gall-fly attack induced tillering and the additional tillers thus produced by the plant seem to compensate the yield for the loss of tillers damaged by gall-fly incidence. This, however, needs to be confirmed.

II. *Date of planting and its relation to incidence of gall-fly.*—In order to study the season in which a particular insect will be abundant and the actual vulnerable stage of the plant, two time bound early maturing varieties viz., Ch.45 and DI.4 were sown and planted at intervals of every fortnight from 18-7-52 to 3-3-53. Random samples of 2' x 2' from each variety, 30 and 60 days after planting, were examined for gall-fly incidence. At the same time the activity of natural parasites on the different stages of gall-fly were also examined. The data showed that (i) Gall-fly incidence was more in 90 days than in 60 days crop, (ii) Variety Ch.45 showed more incidence of gall-fly than DI.4, (iii) Gall-fly incidence was significantly different in the crop planted in different dates. The highest incidence was found on the crop planted in September.

The gall-fly incidence commenced in the month of July in the crop sown on 18th June 1952 and continued till the end of December on the crop sown on 15th December 1952. The peak period of incidence (43.29%) was from beginning to the end of October.

Natural parasitisation of the grubs of gall-fly was first observed in the month of September, and peak period of parasitisation (76.8%) was found to be in the middle of November.

III. *Incidence of stem borers in summer paddy.*—(a) Previous years experiments indicated that there were significant differences between varieties with respect to the stem borer incidence. With a view to finding out the relative susceptibility of rice varieties, grown during summer season, to stem borer observations on 97 varieties were taken. At harvest random samples were taken to estimate the white ear-heads caused by stem borers. The percentage incidence of white ear-heads due to stem borers ranged from 0.9% to 21.0% and the varieties have been grouped into the following categories.

Varieties with over 5% incidence	.	.	.	low resistance.
Varieties with over 1% to 5% incidence	.	.	.	medium resistance.
Varieties with less than 1% incidence	.	.	.	high resistance.

Of the varieties examined, 23 varieties were found to have high resistance.

(b) Experimental evidence indicated that spraying the paddy crop with BHC was effective in reducing the damage by stem borers and increasing the yield. As dusting the insecticide in paddy fields is easier than spraying, 5% BHC dust was used in the experiment. Stem borers cause damage during two stages of the crop *viz.*, at early stage, which results in dead-hearts, and at shot blade stage, which results in white ear-heads. Dustings were designed to be done to synchronise with the brood emergence, which was determined by moth catches at light traps. Early dustings and late dustings were intended to control the incidence at early stage and shot blade stage respectively. A highly susceptible variety, DI.4, was chosen for the experiment and the treatments were as given below :

<i>Pre-transplanting</i>	<i>Post transplanting</i>
1. Control.	1. Control.
2. Nursery dusting plus dipping.	2. Early dusting.
	3. Late dusting.
	4. Early plus late dusting.
	5. Five dustings.

Random samples were uprooted at the peak period of the incidence and at harvest. The data at both stages of the crop indicated that dusting BHC 5 times, effectively controlled the pest which resulted in significantly higher yields by 30.14%. It was also confirmed that stem borer incidence induces subsidiary tillering which do not contribute appreciably towards the yield.

(c) The dosage and the comparative efficiency of spraying and dusting of insecticide *viz.*, BHC, DDT, combination of BHC and DDT and sweet flag, were investigated in an experiment with variety Mtu. 15. Dustings and sprayings were done to synchronise with the brood emergence, which was studied by moth catches at light traps. The data indicated that :—

- (i) In general dusting was more effective than spraying.
- (ii) 10 per cent. dust was more effective than 5 per cent. dust.
- (iii) Combination of BHC and DDT was more effective than DDT or BHC alone.
- (iv) Sweet flag was not as effective as BHC or DDT for field pests.

B. PESTS OF STORED PRODUCTS.

(a) Experimental evidence from the previous years' data indicated that powdered rhizome of sweet flag is more effective in controlling store pests than BHC or DDT. An experiment to find out the effective method of treatment and the optimum dose required for controlling the pests effectively was designed. A bag of 160 lb. of paddy was taken for each treatment. The treatments comprised of control, mixing of sweet flag at 4 oz., 8 oz., and 1 lb. per 100 lb. of grain, dusting of sweet flag at 8 oz. and 1 lb. per 100 sq. ft. surface on the bags. After taking initial counts for the population of pests, the respective treatments were done. The bags were arranged in single tiers on the floor of the godown in randomised positions in 3 replications. Once in a month, three samples of one pound each were drawn at 3 different

places from each bag. Counts of both live and dead of all store pests were individually recorded. The samples and the insects were not put back in the bag. The experiment was conducted for a period of 12 months.

The data showed that mixing sweet flag was more effective than dusting either sweet flag or BHC on the bag. Mixing 1 lb. of powder of sweet flag per 100 lb. of grain gave effective control of pests of stored paddy.

(b) Usually in store houses, paddy or rice, is stored in bags and they are kept one over the other. In order to find out the effect of incidence of pests in relation to the height of the bag, six bags of paddy were kept one over the other in the store house. The experiment consisted of only two replications.

The data showed no significant differences in the incidence of pests in the bags at different heights.

(c) Another experiment was designed to find out the optimum dose of powder of rhizomes of sweet flag required for mixing with rice to control pests of stored rice. The treatments comprised of control, mixing sweet flag powder at 4 oz. 8 oz. and 1 lb. per 100 lb. of rice. The rice chosen was of double polished grade of T.90. 160 lb. of rice was bagged for each treatment replicated thrice. The bags were kept on the floor of the godown on wooden battens in randomised position. The method of sampling was same as that of previous experiment.

The data showed that mixing sweet flag at 8 oz. and 1 lb. per 100 lb. of rice were very effective in controlling pests of stored rice, while 4 oz. was not effective at all.

MYCOLOGY

I. *Study and estimation of resistance to diseases in the collection under genetic stock.*—The reaction of 2568 types in the genetic stock to the diseases commonly occurring at Cuttack was studied. Observations on disease incidence were made on the types at 3 stages, once in the seed bed and twice after transplanting. Four hundred and seventy-five types had developed Helminthosporiose, but out of them, only 25 varieties could be classed as definitely susceptible on the basis of severity of the symptoms observed at one stage or other. 'Blast' appeared on 43 varieties only, out of which 18 showed a "susceptible" reaction. Other minor diseases observed included leaf spots due to *Entyloma oryzae*, *Cercospora oryzae* and grain infection due to *Trichoconis padwickii*.

During the second crop season (December-April), 97 types from the genetic stock, which have been selected for yield trials, were kept under observation for studying their reaction to diseases in the second crop season. Observations on disease incidence were made as was done in

the main season, at three stages. Ten types were found to be susceptible to foot-rot in the seed beds, 33 were found susceptible to *Helminthosporiose* and two blast. Severe root-rot was also found in 13 varieties in the transplanted field.

II. *Helminthosporium disease of rice* : (i) *Study of the relative resistance of selected varieties*.—Twenty varieties, selected as resistant in seedling infection studies in pots during the last four seasons were tested during the year for their resistance under field conditions under both natural and artificial infection. Artificial infection was carried out twice on each variety, once in the seed bed and again at the time of flowering of the respective varieties.

For seed bed infection an area of 1 sq. foot was chosen at random out of an area of $10' \times 5'$ under each variety and seedlings in that area were artificially infected. Only un-infected seedlings from the remaining area were used for transplanting.

The varieties were transplanted in duplicate experimental plots under identical lay-outs, but at two sites in the farm located at a distance from each other. In one of them the varieties were subjected to artificial infection at the time of flowering. Observations on disease incidence were made a few days before harvest of the respective varieties in each plot.

Amongst the twenty resistant varieties were 4 early, 10 medium, 3 late and 3 very late varieties and 3 susceptible varieties of each of the 4 durations were included in the trial for purpose of comparison. Out of the three susceptible varieties of each duration group one was used for flanking the other varieties in that group.

The lay-out was a simple randomised block with 4 replications. The strip plot for each variety was $10' \times 2'-3''$ with 3 rows $9''$ apart planted at $6''$ along the rows. The four duration groups were separated from one another by a path of $3'$ in each replication. Observations on disease incidence were made on 5 random plants in each of the three lines under a variety, a few days after artificial infection had been carried out.

Out of the 20 varieties included in the trial, 6 varieties emerged as relatively resistant ones in the seedling and adult stages. They are Ch. 13, Ch. 45, Co. 20, T. 141, T. 498-2A and BAM. 10.

(ii) *Identification and estimation of conidia over rice fields*.—The study was continued on the lines outlined in earlier reports, with the object of determining the variations in spore population of *Helminthosporium oryzae* in atmosphere over rice fields and correlating the same with meteorological factors. Greased slides were exposed once a week for 24 hours in 6 aeroscopes placed in different parts of the farm. During the examination of slides not only the conidia of *H. oryzae*, but also *Curvularia lunata*, *Trichoconis padwickii*, *Trichoconis*, sp. with dark spores, *Tetraploa* sp., and *Cercospora* sp. were found. The weekly counts of the spores were tabulated along with the weekly average temperature, relative humidity, rainfall etc.

The number of spores caught in the different months of the year are tabulated below :

TABLE XIX.

Name	June 1952	July 1952	Aug. 1952	Sep. 1952	Oct. 1952	Nov. 1952	Dec. 1952	Jan. 1953	Feb. 1953	Mar. 1953	Apr. 1953	May 1953
1. <i>Helminthosporium oryzae</i> .	6	5	3	28	194	24	54	11	11	20	7	1
2. <i>Helminthosporium</i> sp. .	32	42	8	39	36	82	85	81	104	63	28	22
3. <i>Trichoconis padwickii</i> .	..	..	..	5	446	82	1	..	..	..	..	.
4. <i>Trichoconis</i> species with dark spores .	2	12	5	31	41	25	..	11	4	17	31	3
5. <i>Tetraploa</i> sp. . . .	1	18	2	12	14	10	..	3	12	22	8	2
6. <i>Cercospora oryzae</i> . .	2	6	1	18	38	63	15	9	9	62	12	4
7. <i>Curvularia lunata</i> and <i>Curvu-</i> <i>laria</i> sp. .	25	21	4	38	45	..	12	2	17	7	14	4
8. <i>Alternaria</i> sp. . .	22	32	..	19	7	28	..	44	152	75	73	22

As far as the conidia of *H.oryzae* are concerned, the low spore counts in July and August are partially accounted for by the rains on the days the slides were exposed. During September, October and December unusually large number of spores were encountered in certain weeks. Thus 20 out of a total of 28 spores counted in the all weeks of September were trapped on 23rd September 1953; one hundred and sixty-two out of 194 for October were counted on 14th October 1953; and 33 spores out of 54 caught in December were met with on 24th December 1953. When the corresponding meteorological data were compared it was found that sudden increase in the percentage of relative humidity usually a day or two ahead of the date of exposure of slides in the aeroscopes, cloudy weather, increase in the minimum temperature and/or a decrease in the maximum resulting in the lowering of the mean daily range of temperature and rarely light rainfall, were associated with such increased spore catches.

(iii) *Studies on the development of infection.*—With the object of studying the effect of environmental conditions on the phenomenon of infection, plants of varying ages (22, 45, 60, 82 and 105 days old) belonging to one resistant variety, T.141, and two susceptible varieties, T.1145 and Co.13, were infected artificially every alternate month beginning from May, 1952, and the nature and extent of infection which developed were critically observed. The study has to be carried out for at least five seasons before any definite conclusion can be drawn but the results so far obtained are as follows.

Successful infection so far as it relates to penetration of leaf tissue was obtained in all months, but it was least in extent in January, March and May. Regarding the development of lesions after penetration the maximum infection was seen in the months of September and November in T.1145 and Co.13; but in T.141 there was no general development of lesions after penetration in any month except in some plants

of all age groups in July. This development of spots in T.141 appeared more like a reaction zone of discoloration on the part of the host cells rather than like areas of active parasitisation on the part of the pathogen.

(iv) *Studies on resistance.*—In anatomical studies it was found that the lateral extension of discoloured reaction zones is arrested by the presence of large vascular strands, but no clear cut differences between resistant and susceptible varieties were found.

The fungus was grown on a synthetic medium (DOX'S) to which the extracts of leaves from the above three varieties were added. There was no difference either in the dry mycelial weight or in the growth rate between the treatments.

Blast disease of rice.—There were three experiments programmed under blast disease : (i) artificial infection tests for selection of resistant types, (ii) effect of spraying the crop with fungicides on the control of blast and estimation of loss caused by the disease, and (iii) the effect of organic and inorganic N applied as fertilizer on the incidence of blast on rice. The season was unfavourable for blast and very little disease developed in the field experiments and due to lack of facilities for controlling humidity and temperature, artificial infection tests also could not be very effectively carried out. The results obtained this year therefore cannot be considered useful for determination of the relative resistance of the varieties.

Effect of spraying on control of blast and estimation of loss caused by the disease.—In this experiment two varieties Co.13, a very susceptible variety to blast of early duration, and T.1145, a less susceptible one of medium duration, were planted in a randomised split plot layout with the varieties as the main and the spraying treatments as the secondary treatments with a unit plot size of 30' × 10' each. There were five spraying treatments (i) spraying at five stages, once in the seed bed, twice during the growth stage after transplanting and then twice after ear emergence ; (ii) same as above without spraying after ear emergence ; (iii) spraying twice only after ear emergence ; and (iv) unsprayed control. Bordeaux 5:5:50 was used as fungicide. There was slight foliar infection and a low degree of neck infection on Co.13 only. Observations on the incidence of neck infection were taken before harvest on Co.13. The mean neck infection percentage was 13.5 in the unsprayed control, 5.8 in the treatment which had received five sprayings, 10 in the treatment which had received 2 sprayings before ear emergence, 9.2 in the treatment which had received two sprayings after ear emergence. There was no significant relation between yield and infection.

In the second experiment, carried out with the object of estimating the effect of type of manure on the incidence of blast, six varieties, three very susceptible and three moderately susceptible were planted. Ammonium sulphate, groundnut cake, and compost singly and in combination to give 20 and 40 lb. N per acre were applied. There was very little disease and that too was confined to the most susceptible variety

Co.13. The percentage of neck infection was estimated on a random sampling basis on the variety and the data are given in Table XX below :

TABLE XX

Treatment	A/S 20	G.N. 20	Com- post 20	A/S 40	G.N. 40	Com- post 40	A/S 20 G.N. 20	A/S 20 Comp. 20	Comp. 20 G.N. 20	Control
Mean percentage neck infection.	11.2	6.6	8.6	12.3	8.8	13.2	14.4	8.9	10.3	9.5

Differences between the treatments were not significant.

MISCELLANEOUS

I. *Multiplication of improved strains.*—The most popular strains of Orissa viz., T.1145, T.141, T.90, T.1242 and BAM.9 were multiplied and 91618 lb. of seed was produced for distribution.

II. *Determination of optimum time of planting-cum-age of seedlings for strains T.1145 and T.90.*—This experiment with varieties T.1145 and T.90, now in its third year, was continued on the same lines as reported previously. The results are in general in conformity with those of the previous years. For variety T.1145 the data showed that planting of 40 days old seedlings was as good as 30 days old seedlings. Planting as late as 19th August did not affect the grain yield much. The grain yield from planting done in second and third week of August was as good as that of earlier plantings i.e., 20th and 30th July.

In the case of variety T.90, the results of the three years are not consistent. The yield from late planting was as good as from earlier plantings in one year while in other years it was not so; thereby indicating differential response of the strain to seasonal conditions. It would, however, appear that the period 25th July to 9th August was the best for obtaining maximum yield with this variety. Fairly satisfactory yields were obtained upto 24th August after which the yields dropped steeply, the decrease in yield being 25 per cent. as compared to July plantings. The 3 years data are summarised in Table XXI below :

TABLE XXI
Yield in lb. per acre

Date of planting	Age of seedlings (days)	Yield lb./A (unmanured)	% on control	Yield lb./A (manured)	% on control
		<i>Variety</i>	<i>T. 1145.</i>		
20th July	40	1503	95.7	1688	92.7
Do.	30	1578	100.4	1867	102.5
30th July (control). . . .	40	1656	105.4	1764	96.9
Do.	30	1571	100.0	1821	100.0

TABLE XXI—contd.

Yield in lb. per acre

Date of planting	Age of seedlings (days)	Yield lb./A (unmanured)	% on control	Yield lb./A (manured)	% on control
9th August	40	1760	112.0	1754	96.3
Do.	30	1671	106.0	1710	93.9
19th August	40	1527	97.2	1948	106.9
Do.	30	1599	101.8	1810	99.4
29th August	40	1395	88.8	1302	71.5
Do.	30	1299	82.7	1229	67.5
		Variety	T. 90		
25th July	45	2082	118.8	2274	104.7
Do.	35	2112	120.5	2199	101.3
9th August	45	2003	114.3	2217	102.1
Do.	35	1842	105.3	2361	108.7
24th August (control)	45	1752	100.0	2171	100.0
Do.	35	1852	105.7	2150	99.3
8th September	45	1712	97.7	2073	95.5
Do.	35	1674	94.0	2025	93.3
23rd September	45	1675	95.6	1841	84.6
Do.	35	1608	91.8	1646	74.1

III. *Crop sequence in double cropped lands.*—This investigation has now been in progress for the past 3 years with the object to determine the best sequence of first and second crop rice varieties with a green manure crop either preceding the *Kharif* crop or in between the two rice crops. The result of the 3 years show that the best sequence is to grow a long duration rice variety like T.1242 in the *Kharif* season preceded by a green manure crop like *Dhanicha* and followed by a short duration variety like PTB.10 in the second crop season.

IV. *Maximisation of crop yields by heavy manuring.*—In order to investigate the maximum yield that can be obtained by heavy manuring, an acre of land was manured with organic and inorganic fertilizers to give 125 lb. N. 60 lb. P_2O_5 and 15 lb. K_2O and planted with five varieties viz., T.1145, T.1242, T.141, T.90 and BAM.9. As there was rank vegetative growth, the crop in $\frac{3}{4}$ of the area was 'topped' at different stages leaving $\frac{1}{4}$ of the area "un-topped" as control. The yield data are given in table XXII below :

TABLE XXII

Grain and straw yield in lb. per acre

Variety	Grain				Straw			
	Early topping	Late topping	Two toppings	No topping	Early topping	Late topping	Two toppings	No topping
T.1145	1040	640	1940	560	3800	3320	4160	4520
T.141	2620	2960	3640	2120	4660	4820	4360	4820
T.90	2380	2400	2740	2100	4600	5840	4180	5380
T.1242	2880	2520	3240	2020	6360	5540	6340	5150
BAM. 9	2380	2240	2520	1980	5280	5040	5340	4800

The best grain yields were obtained when 'two toppings' (one early and one late) were given and the poorest yields were obtained with 'no topping'. The increase in yield was as much as 71·7 per cent. in case of T.141 and 60 per cent. in case of T.1242. The very low yield in 'no topping' obtained with T.1145 was due to the considerable unsettling caused by severe lodging of the variety.

During the second crop season variety Co.13 was grown in the same field and manured to give 140 lb. N and 40 lb. P_2O_5 . The crop was affected both by blast disease and stem borer and consequently the yield was poor, being only 1441 lb. per acre.

V. *Maximum yield potential experiment.*—As previously reported, this permanent experiment has been designed to determine the extent to which yield can be stepped up by adopting all the departmental recommendations with regard to rice cultivation. This year on the 4·8 acre reserved for the experiment, *dhanicha*, to give about 4000 lb. of green matter, was grown and incorporated in the soil. A basal dose of 200 lb. superphosphate per acre and top dressing at 100 lb. ammonium sulphate per acre were given. The crop (variety T.1242) gave an yield of 2089 lb. of grain and 4322 lb. of straw per acre.

VI. *Intensive Cultivation Centre.*—Propaganda and demonstration of improved cultivation practices and distribution of seed were continued in the Intensive Cultivation Centre. The more important items of work done are given below :

- (i) 690 mds. seed of improved varieties from the Institute was distributed. Besides this 400 mds. of improved seed obtained from cultivators, who were given improved seed last year, was distributed to other cultivators in the same village.
- (ii) 50 mds. of *dhanicha* seed was distributed for green manuring purposes. Growing of *dhanicha* plants along the bunds for seed purposes and utilizing wild *cassia* plant, growing in the bunds for green leaf manure were popularised.
- (iii) 1882 mds. of ammonium sulphate was supplied for fertilizing the rice and potato crops.
- (iv) 2800 mds. of municipal compost was also supplied and compost making demonstrated.
- (v) Transplanting was demonstrated in 100 acres distributed in four villages.
- (vi) 311 grafts of mango, orange, sapota, etc., were distributed.
- (vii) *Taccavi* loans, amounting to Rs. 52,195 were given to the cultivators.

Training.—An 'International Training Centre on Rice Breeding' was conducted at the Institute in collaboration with the FAO of the United Nations. The 3 months training course (15th September to 15th

December 1952), which was inaugurated by the Union Minister of Agriculture, was attended by 23 trainees coming from India and 9 other countries, viz., Ceylon, Egypt, France, Indonesia, Iran, Laos, Pakistan, Philippines and Thailand.

Publication.—Ramiah, K., Ghose, R. L. M. and Vachhani, M. V. (1952)—Improvement of rice in India. *Empire Jour. Exper. Agri.* 20 : 161-174.

Abichandani, C. T. (1953)—Use of sulphate of ammonia for wet paddy lands. *Rice News Tiller* 1:8-14.

PROGRAMME OF WORK FOR 1953-54.

Agronomy Division—

(i) Coordinated yield trials of indigenous and exotic improved varieties of paddy at the Institute and various rice growing areas in different States.

(ii) Determination of the optimum dose, time and method of application of manures and fertilizers and their residual and cumulative effect on the soil fertility.

(iii) Study of the relative efficiency of various nitrogenous fertilizers.

(iv) Trial of suitable varieties for double cropping.

(v) Study of the suitability of various crops for growing in rotation with rice.

(vi) Study of efficiency of herbicides for control of weeds in the rice fields and determine the optimum time and method of their application.

(vii) Trial of small machines for rice cultivation and processing.

Statistics—

(i) Continuation of studies in sampling :

(a) sampling for straw—grain ratio

(b) pollen sterility counts.

(ii) Uniformity trial with :

(a) bulk transplanted crop.

(b) broadcast crop.

(iii) Border effect both from varietal trials and manurial trials.

Botany Division—

(i) Maintenance and study of genetic stocks.

(ii) Maintenance of nucleus seed of improved strains.

(iii) Improving yields by :

(a) introduction

(b) hybridization—

1. between *japonica* and *indica* groups,

2. within *indica* groups.

(iv) Breeding for high fertility soil conditions.

(v) Breeding for upland conditions.

(vi) Breeding for disease resistance.

(vii) Study of secondary selections.

(viii) *Genetics* :

(a) linkage groups

(b) resistance to blast

(c) dwarfs

(d) pigmentation

(e) sterility

(ix) *Physiology* :

(a) response of varieties to drought.

(b) response of varieties to photoperiod.

(x) *Cytogenetics*.—Causes of sterility in *japonica* and *indica* hybrids.

Chemistry Division :

(i) Investigations on nitrogen transformation in soils under water-logged conditions.

(ii) Analysis of unoxidised rice soil and investigations on determination of available nutrients under water-logged conditions.

(iii) Investigations on direct, residual and cumulative effect of different phosphatic fertilizers and lime on growth and yield of rice crop.

(iv) Investigations on use of micro-nutrients to increase yield of rice crop.

(v) Placement trials with fertilizers—seed placement and sub-surface placement.

Entomology Division :

(i) Study of reactions of genetic stocks to pests with a view to isolating resistant strains to insect damage (*Sarad* and *Dalua* varieties).

(ii) Varietal susceptibility and agronomic practices in their relation to pests in general and borers and gall-fly in particular.

(iii) Estimation of loss due to pests, particularly *Hispa*, *Schoenobius*, *Pachydiplosis* and *Leptocorisa* in the field and *Sitotroga*, *Calandra* and *Tribolium* in the stored grains.

(iv) Effect of gall-fly and borer attack on tillering and yield.

(v) Studies on gall formation in paddy.

(vi) Insecticidal trials to control pests in the field and store house.

(vii) Trials with systemic insecticides to control field pests.

(viii) Investigations on the utilization of the indigenous plant product as insecticide.

(ix) Studies of alternate hosts of major pests of paddy.

(x) Collection of indigenous parasites with a view to utilising them for biological control of pests of paddy.

(xi) Bionomics of *Pachydiplosis* and *Schoenobius*.

Mycology Division :

(i) Study and estimation of resistance to diseases namely, *Blast* and *Helminthosporium*, in the collection under genetic stock.

(ii) *Helminthosporium* disease :

- (a) Tests of resistance of selected varieties under natural and artificial infection.
- (b) Studies on the nature of resistance of rice varieties to *Helminthosporium* disease.
- (c) Investigation of collateral hosts. Identification of pathogens and cross inoculation studies.
- (d) Identification and estimation of air-borne conidia over rice fields.
- (e) Estimation of loss in yield due to the disease.
- (f) Breeding resistant varieties.

(iii) *Blast Disease* :

- (a) Varietal susceptibility trials.
 - (b) Breeding resistant varieties.
 - (c) Control of Blast by spraying and efficiency of different fungicides.
 - (d) Estimation of loss in yield caused by Blast.
- (iv) Seed treatment of rice with fungicides.

Farm Division :

(i) Multiplication of improved rice varieties.

(ii) Investigation of the comparative efficiency of broadcasting in puddle *aman* varieties and transplanting.

(iii) Determination of the optimum seed rate required for late *aman* rice under drilling and broadcast sowing.

(iv) Investigation of the influence of seed harvested at different periods after flowering on the yield of the subsequent crop.

(v) Maximisation of crop yield by heavy manuring and under improved methods of cultivation.

(vi) Demonstration and propaganda in the Intensive Cultivation Centre.

STAFF (1952-1953).

Director	Dr. S. Ramanujam, M.A., Ph.D. (Lond.), F.N.I., upto 11th September, 1952. Dr. N. Parthasarathy, Ph.D. (Lond.), F.N.I., from 12th September, 1952.
--------------------	--

Agronomy Division—

Agronomist	Dr. Moti V. Vachhani, B.Ag., Ph.D. (Minn.).
Research Assistant	Shri C. P. K. Nair, B.Sc. (Agri).
Do.	Shri S. R. Upadhyaya, M.Sc.

Statistics—

Statistician	Shri T. P. Abraham, M.A.
------------------------	--------------------------

Botany Division—

Geneticist & Botanist	Shri R. L. M. Ghose, M.Sc., F.A.Sc.
Assistant Botanist	Shri W. T. Butany, B.Sc.(Agri.)(Hons.), Assoc. I. A.R.I.
Research Assistant	Shri L. R. Daiya, B.Ag.
Do.	Shri R. K. Misra, M.Sc.
Do.	Shri R. Seetharaman, M.Sc.

Chemistry Division—

Assistant Chemist	Dr. C. T. Abichandani, M.Sc., Ph.D., A.R.I.C.
Research Assistant	Shri S. C. Chakravarty, M.Sc., upto 2-12-1952. Shri S. N. Patnaik, M.Sc. from 11-12-1952.

Entomology Division—

Entomologist	Shri P. Israel, M.A., F.R.E.S.
Research Assistant	Shri G. Vedamoorthy, M.A., Assoc. I. A. R. I.
Do.	Shri Y. Seshagiri Rao, M.Sc.

Farm Division—

Farm Superintendent	Shri M. Subbiah Pillai, B.A., B.Sc. (Agri.).
Research Assistant	Shri N. A. Parasuram, B.Sc. (Agri.).
Do.	Shri C. N. Relwani, B.Sc. (Agri.).

Mycology Division—

Mycologist	Shri S. Y. Padmanabhan, B.Sc. (Hons.), M.A., Assoc. I.A.R.I.
Assistant Mycologist	Shri Durgadas Ganguly, M.A.
Research Assistant	Shri G. H. Chandwani, B.Sc. (Agri.).



